CLAIMS

What is claimed is:

1. A substrate imaging system, comprising:

a carrier holding a substrate;

a platen holding a polishing pad;

a frame for disposing the platen relative to the carrier; and

an reflectance image processing subsystem for acquiring one or more two-dimensional images of the substrate during CMP of the substrate and deriving therefrom information about the substrate useful for subsequent CMP of the substrate.

2. The system of claim 1 further comprising a means for rotating the platen.

3. The system of claim 1 wherein the reflectance image processing subsystem further comprises a means for capturing a plurality of one-dimensional reflectance images and deriving the one or more two-dimensional images therefrom.

4. The system of claim 1 wherein the substrate further comprises a pad-contacting surface.

5. The system of claim 4 wherein the reflectance image processing subsystem further comprises a means for capturing a plurality of one-dimensional images from light reflected from the pad-contacting surface, and deriving the one or more two-dimensional images therefrom.

6. The system of claim 1 wherein the one or more two-dimensional images comprise spectral images.

7. The system of claim 1 wherein the one or more two-dimensional images are derived from data points.

8. The system of claim 7 wherein the data points are substantially contiguous.

9. The system of claim 7 wherein the data points are substantially non-contiguous.

10. A substrate imaging system comprising:

a carrier holding a substrate, the substrate having a pad-contacting surface;

a platen holding a polishing pad;

a frame for operatively disposing the platen relative to the carrier; and

an image processing subsystem for capturing, from light reflected from the pad-contacting surface and transmitted through one or more optically transparent elements in the platen and/or polishing pad, a plurality of one-dimensional images representative of at least a portion of the pad-contacting surface of the substrate during traversal of the opening and/or optically transparent elements, and deriving therefrom a frame comprising frame data providing information about the substrate useful for subsequent chemical-mechanical processing of the substrate.

11. The system of claim 10 further comprising a means for rotating the platen.

12. The system of claim 10 wherein the one-dimensional images comprise line images.

13. The system of claim 10 wherein the image processing subsystem comprises a light source, a first bundle of optical fibers carrying light from the light source to the slit in the platen, and a second bundle of optical fibers carrying light reflected from the pad-contacting surface to a wavelength dispersive element for dissecting spatial components of the one-dimensional images into their respective wavelength components.

14. The system of claim 13 wherein the image processing subsystem further comprises a two-dimensional imager having a spatial dimension and a spectral dimension for receiving

the dissected light from the wavelength dispersive element, and providing a two-dimensional collection of data for each of the one-dimensional images, a first dimension of the collection comprising a spatial dimension, and a second dimension of the collection comprising a spectral dimension, and a processor for deriving a frame from a plurality of the two-dimensional collections.

15. The system of claim 13 wherein the optical fibers in the first and second bundles each have terminating ends arranged in a fiber assembly element fitted to an underside of the platen.

16. The system of claim 15 wherein the terminating ends of the fibers are arranged in an arrangement in which terminating ends of fibers in the first bundle form first and second rows, and the terminating ends of fibers in the second bundle form a third row placed between the first and second rows.

17. A whole-substrate imaging system comprising:

a carrier holding a substrate, the substrate having a pad-contacting surface with a maximum planar dimension;

a platen having a radius and holding a polishing pad, the platen including a slit having a length equal to or exceeding the maximum planar dimension of the substrate, the length disposed substantially along the platen radius, and the polishing pad having an optically transparent element located at about the slit;

a frame for operatively disposing the platen relative to the carrier, such that the pad-contacting surface of the substrate contacts the polishing pad, and substantially completely traverses the slit when the pad-contacting surface moves relative to the platen; and

an image processing subsystem for capturing, from light reflected from the pad-contacting surface and transmitted through the optically transparent element and the slit, a plurality of one-dimensional images representative of the substantial entirety of the pad-contacting surface of the substrate during traversal of the pad-contacting surface past the slit, and deriving therefrom a frame comprising frame data useful for subsequent chemical-mechanical processing of the substrate.

18. The system of claim 17 further comprising a means for rotating the platen.

19. The system of claim 17 wherein the one-dimensional images comprise line images.

20. The system of claim 17 wherein the image processing subsystem comprises a light source, a first bundle of optical fibers carrying light from the light source to the slit in the platen, and a second bundle of optical fibers carrying light reflected from the pad-contacting surface to a wavelength dispersive element for dissecting spatial components of the one-dimensional images into their respective wavelength components.

21. The system of claim 20 wherein the image processing subsystem further comprises a two-dimensional imager having a spatial dimension and a spectral dimension for receiving dissected light from the wavelength dispersive element, and providing a two-dimensional collection of data for each of the one-dimensional images, a first dimension of the collection comprising a spatial dimension, and a second dimension of the collection comprising a spectral dimension, and a processor for deriving a frame from a plurality of two-dimensional collections.

22. The system of claim 20 wherein the optical fibers in the first and second bundles each have terminating ends arranged in a fiber assembly element fitted to an underside of the platen.

23. The system of claim 22 wherein the terminating ends of the fibers are arranged in an arrangement in which terminating ends of fibers in the first bundle form first and second rows, and the terminating ends of fibers in the second bundle form a third row placed between the first and second rows.

24. A whole-die imaging system comprising:

a carrier holding a substrate, the substrate having a pad-contacting surface forming a die and having a maximum planar dimension;

a rotating platen having a radius and holding a polishing pad, the platen including a slit having a length approximately equal to the maximum planar dimension of the die, the length disposed substantially along the platen radius, and the polishing pad having an optically transparent element located at about the slit;

a frame for operatively disposing the rotating platen relative to the carrier, such that the pad-contacting surface of the substrate contacts the polishing pad, and substantially completely traverses the slit within a rotation of the platen; and

an image processing subsystem for capturing, from light reflected from the pad-contacting surface and transmitted through the optically transparent element and the slit, a plurality of one-dimensional images representative of the substantial entirety of the pad-contacting surface of the die during traversal of the pad-contacting surface past the slit, and deriving therefrom a frame comprising frame data providing information about the die useful for subsequent chemical-mechanical processing of the substrate.

25. The system of claim 24 wherein the one-dimensional images comprise line images.

26. The system of claim 24 wherein the image processing subsystem comprises a light source, a first bundle of optical fibers carrying light from the light source to the slit in the platen, and a second bundle of optical fibers carrying light reflected from the pad-contacting surface to a wavelength dispersive element for dissecting spatial components of the one-dimensional images into their respective wavelength components.

27. The system of claim 26 wherein the image processing subsystem further comprises a two-dimensional imager having a spatial dimension and a spectral dimension for receiving dissected light from the wavelength dispersive element, and providing a two-dimensional collection of data for each of the one-dimensional images, a first dimension of the collection comprising a spatial dimension, and a second dimension of the collection comprising a spectral dimension, and a processor for deriving a frame from a plurality of two-dimensional collections.

28. The system of claim 26 wherein the optical fibers in the first and second bundles each have terminating ends arranged in a fiber assembly element fitted to an underside of the platen.

29. The system of claim 28 wherein the terminating ends of the fibers are arranged in an arrangement in which terminating ends of fibers in the first bundle form first and second rows, and the terminating ends of fibers in the second bundle form a third row placed between the first and second rows.

30. A system for imaging a substrate during CMP, comprising:

a carrier holding a substrate, the substrate having a pad-contacting surface;

a rotating platen holding a polishing pad;

a frame for operatively disposing the rotating platen relative to the carrier; and

an image processing subsystem for capturing, from light reflected from the pad-contacting surface and transmitted through one or more optically transparent elements in the platen and/or polishing pad, data points representative of at least a portion of the pad-contacting surface of the substrate during traversal of the opening and/or optically transparent elements, and deriving therefrom one or more one-dimensional reflectance images of a portion of a substrate, where data point spacing is determined by an array of data collection locations disposed substantially non-parallel to the direction of substrate motion.

31. The system of claim 30 where the data points used for deriving the one or more images are substantially contiguous.

32. The system of claim 31 where the data points used for deriving the one or more images are substantially non-contiguous.

33. The system of any of claims 30, 31, and 32 where the one or more images are spectral images.

34. The system of claim 30 where the image processing subsystem aggregates the one-dimensional images to form a two-dimensional image of the substrate, and the two-dimensional image provides information about the substrate useful for subsequent chemical-mechanical processing of the substrate.

35. The system of claim 34 where the image processing subsystem forms one or more two-dimensional images of at least a portion of the substrate.

36. The system of claim 35 where the data points used for deriving the one or more images are substantially contiguous.

37. The system of claim 35 where the points used for deriving the one or more images are substantially non-contiguous.

38. The system of claims 36 or 37 where the one or more two-dimensional images comprise spectral images.

39. A method for polishing a semiconductor substrate, comprising:
acquiring one or more two-dimensional images of the substrate during CMP; and
deriving therefrom information about the substrate useful for subsequent chemical-mechanical processing of the substrate.

40. The method of claim 39 wherein the derived information comprises frame data suitable for reproducing the one or more two-dimensional images.

41. The method of claim 39 wherein each two dimensional image comprises a plurality of one-dimensional images, each one-dimensional image reflected from a different portion of the substrate.

42. The method of claim 39 wherein the one or more two-dimensional images comprise spectral images.

43. A method of imaging a substrate comprising:

holding a substrate having a pad-contacting surface;

holding a polishing pad with a platen including one or more optically transparent elements;

operatively disposing the rotating platen relative to the pad-contacting surface, such that the pad-contacting surface contacts the polishing pad, and substantially completely traverses the one or more optically transparent elements within a rotation of the platen;

capturing, from light reflected from the pad-contacting surface and transmitted through the one or more optically transparent elements, a plurality of one-dimensional images representative of at least a portion of the pad-contacting surface during traversal of the pad-contacting surface past the optically transparent elements; and

deriving therefrom a frame comprising frame data useful for subsequent chemical-mechanical processing of the substrate.

44. The method of claim 43 wherein the platen comprises a rotating platen.

45. The method of claim 43 wherein the capturing step comprises:

carrying light from a light source to the optically transparent elements in the platen;

carrying light reflected from the pad-contacting surface to a wavelength dispersive element; and

dissecting spatial components of the one-dimensional images into their respective wavelength components.

46. The method of claim 44 wherein the capturing step further comprises:

receiving, at a two-dimensional imager having a spatial dimension and a spectral dimension, dissected light from the wavelength dispersive element; and

providing a two-dimensional collection of data for each of the one-dimensional images, a first dimension of the collection comprising a spatial dimension, and a second dimension of the collection comprising a spectral dimension.

47. The method of claim 46 wherein the deriving step comprises deriving a frame from a plurality of the two-dimensional collections.

48. A method for aquiring a two-dimensional image of a substrate during CMP, comprising:

holding a substrate, the substrate having a pad-contacting surface and a maximum planar dimension;

holding a polishing pad with a rotating platen, the platen having a radius and including a slit having a length disposed substantially along the radius of the platen and equal to or exceeding the maximum planar dimension of the substrate, the platen also including an optically transparent element located at about the slit;

operatively disposing the rotating platen relative to the pad-contacting surface, such that the pad-contacting surface of the substrate contacts the polishing pad, and substantially completely traverses the slit within a rotation of the platen;

capturing, from light reflected from the pad-contacting surface and transmitted through the optically transparent element, a plurality of one-dimensional images representative of the substantial entirety of the pad-contacting surface of the substrate during traversal of the pad-contacting surface past the slit; and

deriving therefrom a frame comprising frame data providing information about the substrate useful for subsequent chemical-mechanical processing of the substrate.

49. The method of claim 48 wherein the capturing step comprises:

carrying light from a light source to the slit in the platen;

carrying light reflected from the pad-contacting surface to a wavelength dispersive element; and

dissecting spatial components of the one-dimensional images into their respective wavelength components.

50. The method of claim 49 wherein the capturing step further comprises:

receiving, at a two-dimensional imager having a spatial dimension and a spectral dimension, dissected light from the wavelength dispersive element; and

providing a two-dimensional collection of data for each of the one-dimensional images, a first dimension of the collection comprising a spatial dimension, and a second dimension of the collection comprising a spectral dimension.

51. The method of claim 50 wherein the deriving step comprises deriving a frame from a plurality of the two-dimensional collections.